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The Influence of Sieve Mesh Size Selectivity on Benthic Invertebrate Indices of Eutrophication

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16. ABSTRACT

The selective retention of benthic invertebrates by sieves of various mesh sizes was demonstrated by Jonasson (1955, 1958) who reported that decreasing the mesh opeining from 0.62 to 0.51 mm (effective decrease on one-third mesh opening area) resulted in samples with an average of 47% more Tanypus chironomid larvae. Sieve mesh size was also found to be highly selectrive toward oligochaetes of particular size ranges. Studies of Kajak (1963), Heuschele (1969), and Mundie (1971) supported Jonasson's findings that the head capule width of chironomid larvae governed their retention.

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THE INFLUENCE OF SIEVE MESH SIZE SELECTIVITY ON BENTHIC INVERTEBRATE INDICES OF EUTROPHICATION*

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The selective retention of benthic invertebrates by sieves of various mesh sizes was demonstrated by JÓNASSON (1955, 1958) who reported that decreasing the mesh opening from 0.62 to 0.51 mm (effective decrease of one-third mesh opening area) resulted in samples with an average of 47 % more *Tanypus* chironomid larvae. Sieve mesh size was also found to be highly selective toward oligochaetes of particular size ranges. Studies of KAJAK (1963), HEUSCHELE (1969), and MUNDIE (1971) supported JÓNASSON's findings that the head capule width of chironomid larvae governed their retention.

Sieve mesh size selectivity has resulted in the recognition of two major artificial categories of benthic invertebrates; Macroinvertebrates, those invertebrates retained by U. S. Standard No. 30 sieve (0.595 mm mesh opening, 0.354 mm^2 area) and Microinvertebrates, those invertebrates not retained by this sieve mesh (WEBER 1973). These categories transect taxonomic units since the individuals of certain species may be retained or lost depending upon the larval developmental stage, sieve mesh opening, clogging of the openings by debris, and washing effort.

For uniformity, it would be preferable to keep samples intact without sieving. However, the large volume of detrital material in grab bottom samples causes an exhorbitant expenditure in sample analysis time. The problem of rapid sample analysis is particularly acute in water quality surveys where hundreds of samples may be analysed each year. However, additional time for processing the whole sample would be justified if the results obtained from sample partitioning would yield false information regarding the water quality status.

The 1972 U.S. Water Quality Act Amendment[1] Section 106 (e) (1) provides that State water quality monitoring programs will classify all navigable water according to eutrophic condition. Section 314 (a) (1) provides that a eutrophic condition inventory be made of all publically owned fresh water lakes.

In recent years, mathematical indices have attracted considerable attention because they offer a quasi-objective means of summarizing biological data in relation to the effects of eutrophication. The most notable eutrophication indices proposed for benthic invertebrate communities include: the index of Species Richness (D), the Community Diversity Index ($\bar{d}$) (WILHM 1967), the Trophic Condition Index (T.C.I.) proposed by BRINKHURST et al. (1968), and CHUTTER's (1972) Empirical Biotic Index (E.B.I.).

The purpose of this study was to determine if sieve mesh size selectivity of three screens: U.S. Standard Nos. 30, 40, and 60 (0.595, 0.420, and 0.250 mm mesh openings, respectively) significantly altered the eutrophic classification of rivers and a reservoir, based on the four biological indices of eutrophication listed above.

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[1] *Federal Water Pollution Control Act Amendments of 1972*: Available from: Water Pollution Control Federation, 3900 Wisconsin Avenue, Washington, D. C. 20016, U.S.A.

Methods

Comparison of the Nos. 30 and 40 sieves was based on samples taken in six replicates (reps.) with a PONAR grab (522.6 mm^2) in August, 1970 from four Ohio River Basin streams near Cincinnati, Ohio: Little Miami River (mud), Ohio River (silt), and Great Miami River (sand), and the Scioto River (gravel). The Ohio River Basin samples were first screened in a No. 30 sieve and the filtrate screened again through a U. S. Standard No. 40 sieve. The results reported for the No. 40 sieve include the contents of the Nos. 30 and 40 sieves.

Differences between the Nos. 30 and 60 sieves were determined for PONAR grab samples collected on eight occasions during 1971 in silt substrate of the Lewis and Clark Reservoir, South Dakota. Samples from Lewis and Clark Reservoir were sieved once, in either a No. 30 or a No. 60 sieve (2 reps each).

Bottom sediment types were categorized by dry analysis according to CUMMINS' (1962) modification of the WENTWORTH particle size classification except that the silt-clay fraction was termed "silt" if upon drying it had a fine, granular consistency, and termed "mud" if the particles adhered forming hard lumps.

The samples were sorted and identified as described in WEBER (1973). Identifications for the majority of organisms were carried to genus and species. Chironomid pupae were not identified and were omitted from the totals since they would not fit into the calculation of $\bar{d}$, T.C.I., and E.B.I. Bryozoa were omitted because individual colonies could not be differentiated.

Index equations and the corresponding eutrophic classification of water are contained in Tab. 1. The merits and disadvantages of each index will not be described since the original papers provide sufficient details as to their meaning. It should be noted, however, that D is heavily weighted by the total number of individuals per sample; $\bar{d}$ takes into account the distribution of individuals among the taxa; and T.C.I. and E.B.I. take into consideration the tolerance of each taxon to environmental stress. The tolerance rank of each organism in calculating the latter two indices was assigned subjectively by extensive familiarity with habitat preferences of the species and through supportive environmental requirement information contained in the literature. Those organisms least tolerant to organic pollution were assigned a value near zero, whereas those species tolerant to pollution were assigned a value near 10 (E.B.I.) or 2 (T.C.I.). Generally, a tolerance of 5 (E.B.I.) or 1 (T.C.I.) was assigned to taxonomic groups with unknown environmental preferences.

Results and discussion

The No. 30 sieve retained 30% fewer individuals from sand and gravel of the Ohio River Basin than did the No. 40 sieve, and in silt and mud, the No. 30 sieve retained 70% fewer individuals (Tab. 2). Differences between individuals retained in the silt samples were significant ($F = 9.22$; $df = 1, 10$; $P = .05$), and those in mud substrates were highly significant ($F = 19.04$; $df = 1, 10$; $P = .01$) (Tab. 3). Except for mud substrate, the No. 30 sieve retained almost the same taxa as did the No. 40. The majority of organisms which were collected from mud and were missed by No. 30 sieve were cylindrical shaped (Tab. 2). These included organisms such as the chironomid *Procladius denticulatus*, and oligochaetes. These data support the findings of the other studies (mentioned above) that the use of a No. 30 sieve may result in large underestimates of standing crop of benthic invertebrates. The mean coefficient of variation (CV = 1SD 100/x) for the total individuals collected in all substrates averaged 12.1% greater with the No. 30 sieve than with the No. 40 sieve.

Tab. 1. Biological pollution index classification.

Index	Formula	Where	Eutrophic pollutional classification
Species richness index (D)	$D = \frac{S-1}{\ln N}$	S = total taxa N = total # individuals	(see $\bar{d}$)

Community diversity
$\bar{d} = -\Sigma (n_i/N \cdot \mathrm{Log}_2 n_i/N)$
	$\bar{d} = -\sum_{i=1}^{s} (ni/N \cdot \mathrm{Log}_2 ni/N)$	ni = # individuals in the *i*th taxon
		N = total # individuals/sample
		s = number of taxa
			< 1 = polluted H_2O
			> 3 = clean H_2O

Trophic condition index (T.C.I.)	$T.C.I. = \frac{\Sigma N_1 + 2\Sigma N_2}{\Sigma N_0 + \Sigma N_1 + \Sigma N_2}$	N_0 = # intolerant organisms N_1 = # facultative organisms N_2 = # tolerant organisms	0 = maximum oligotrophy 2 = maximum eutrophy

Empirical biotic index (E.B.I.)	$E.B.I. = \frac{\Sigma (a \cdot b)}{N}$	a = # in *i*th taxon
		b = quality value (0—10) of *i*th taxon
		N = total # of individuals
			0— 2 = clean H_2O
			2— 4 = slightly enriched H_2O
			4— 7 = enriched H_2O
			7—10 = polluted H_2O

Tab. 2. Mean number of benthic invertebrates per sample and biological indices for Ohio River Basin taken with a PONAR grab (6 reps.), August, 1970.

Organism:	Pollutional rank (0—10)	(N_0,N_1,N_2)	Mud		Silt		Sand		Gravel	
			US 30	/ US 40[1]	US 30	/ US 40[1]	US 30	/ US 40[1]	US 30	/ US 40[1]
Diptera										
Chironomidae										
Tanypodinae										
A. mallochi	8	2					0.3	0.3		
Coelotanypus scapularis	7	1			6.7	11.0	1.2	1.2		
Conchapelopia rurika	7	1					0.2	0.2	9.2	12.0
Guttipelopia multipunctata	5	1							2.2	2.7
Procladius denticulatus	9	2	75.3	205.8	2.5	13.5	2.2	3.7		
Zavrelimyia sinuosa	3	0						0.2		
Orthocladiinae										
Orthocladiinae n. sp.	5	1						0.2		
Psectrocladius simulans	4	1					1.3	1.7	0.5	0.6
Thienemanniella xena	1	0							0.2	0.2
Chironominae										
Chironomini										
Chironomus attenuatus gr.	9	2		0.3			0.3	0.3		
Cryptochironomus fulvus gr.	7	1	0.2	0.2	1.7	3.2	19.7	28.5	6.5	8.8
C. blarina	7	1			0.2	0.5				
Glyptotendipes meridionalis	5	1		0.2						
Dicrotendipes nervosus	8	2	1.2	2.2					0.5	0.5
Parachironomus abortivus	6	1							0.2	0.2
Paracladopelma nais	4	1			0.2	0.2	0.5	0.5		
Polypedilum halterale	5	1					0.5	0.7	11.5	13.7
P. illinoense	6	1		0.7					30.8	32.8
P. n. sp. 1	7	1					33.2	38.5	59.8	77.7
P. n. sp. 2				0.2					0.2	0.2
Tanytarsini										
Rheotanytarsus sp.	6	1		0.2					52.5	64.3

[1] Contents of No. 30 and No. 40 sieves combined.

Tab. 2 continued

Organism: 1970	Pollutional rank (0—10)	(N_0.N_1.N_2)	Mud US 30	Mud US 40¹	Silt US 30	Silt US 40¹	Sand US 30	Sand US 40¹	Gravel US 30	Gravel US 40¹
Empididae										
Hemerodromia	5	1							03	0.3
Ceratopogonidae	5	1	0.2	0.2	0.2	0.2	0.2	0.2	03	0.3
Culicidae										
Chaoborus sp.	5	1	0.3	0.5	0.8	0.8				
Tricoptera										
Hydropsychidae										
Potamyia flava	6	1							279.8	288.3
Hydropsyche orris	5	1							F	F
Leptoceridae										
Oecetis eddelstoni	3	0			0.2	0.2			0.2	0.2
Hydroptilidae										
Hydroptila sp.	3	0	0.3	0.3						
Ephemeroptera										
Caenidae										
Caenis sp.	6	1							10.0	11.5
Tricorythodes sp.	6	1							0.5	0.6
Heptageniidae										
Stenonema terminatum	5	1							0.3	0.5
Baetidae										
Baetis sp.	3	0						0.2	0.2	0.2
Coleoptera										
Elmidae										
Stenelmis sp.	6	1		0.2					0.8	0.8
Staphylinidae	5	1								0.2
Odonata										
Anisoptera										
Gomphidae										
Dromogomphus sp.	7	1			0.2	0.2				
Oligochaeta										
Naididae	6	1				1.0	0.8	14.0	1.8	2.7
Tubificidae	9	2	9.8	93.2	20.3	65.5	39.8	61.3	0.2	0.2

Organism: 1970	Pollutional rank (0—10)	(N_0,N_1,N_2)	Mud US 30 / US 40[1]		Silt US 30 / US 40[1]		Sand US 30 / US 40[1]		Gravel US 30 / US 40[1]	
Nematoda	5	1		0.5		0.2	0.3	0.3	0.2	0.2
Mollusca										
Bivalvia										
Pisidium sp.	4	1							1.0	1.0
Proptera sp.	5	1							0.2	0.2
Sphaerium sp.	5	1							0.8	1.0
Corbicula manilensis	6	1			0.3	0.3				
Gastropoda										
Goniobasis	5	1					1.3	1.3	22.6	22.8
Somatogyrus sp.	5	1							1.2	1.2
Ferrissia sp.	3	1					0.3	0.3	1.2	1.2
Helisoma sp.	3	1					0.3	0.3	0.2	0.2
Physa sp.	8	2							0.2	0.2
Gyraulus sp.	4	1	0.3	0.3	0.3	0.3	0.3	0.3		
Planorbula sp.	4	1	0.3	0.3						
	Individuals x		87.9	305.3	33.6	97.1	102.7	154.2	496.1	547.5
	± 1 SD		40.9	98.3	20.6	48.2	71.8	78.3	217.0	221.6
	CV (%)		46.5	32.2	61.3	49.6	69.8	50.8	43.7	40.5
	Total Taxa		9	16	12	14	18	21	32	33
	Taxa/Sample x		3.8	5.7	4.8	6.2	5.7	8.2	12.0	13.2
	± 1 SD		0.7	2.2	0.75	1.30	2.0	2.1	2.70	3.70
	CV %		19.6	39.7	15.6	21.5	34.7	26.2	23.0	27.8
	Dx		0.6	0.7	1.2	1.2	1.0	1.4	1.9	1.9
	± 1 SD		0.25	0.38	0.19	0.42	0.36	0.31	0.50	0.50
	$\bar{d}$ x		0.6	1.0	1.2	1.2	1.5	1.8	2.0	2.0
	± 1 SD		0.24	0.14	0.48	0.38	0.23	0.45	0.33	0.16
	TCIx		1.40	1.40	1.50	1.50	1.30	1.00	0.97	0.97
	± 1 SD		0.16	0.14	0.26	0.20	0.21	0.11	0.05	0.04
	EBI x		8.9	9.2	9.2	9.4	8.0	7.7	4.5	4.4
	± 1 SD		0.29	0.07	0.29	0.23	0.99	0.89	0.20	0.05

[1] Contents of No. 30 and No. 40 sieves combined.

Tab. 3. Calculated F-values for one-way ANOVA for Ohio River Basin samples sieved in No. 30 and No. 40 mesh screen — August, 1970, and Lewis and Clark Reservoir samples sieved in No. 30 and No. 60 mesh screen, 1971.

	Ohio River Basin[1]				Lewis and Clark Reservoir[2]
	Mud	Silt	Sand	Gravel	Silt
Total individuals	19.04**	9.22*	1.49	1.18	119.20**
Total taxa	3.60	4.57	4.45	0.89	70.29**
D	0.43	0.06	4.31	0.60	37.20**
$\bar{d}$	8.75*	0.01	7.03*	0.11	17.55**
T.C.I.	0.82	0.01	4.72	0.06	4.39
E.B.I.	6.49*	2.73	0.18	0.07	5.46

[1] = 1, 10 df
[2] = 1, 30 df
* = Significant at 95 % C.L.
** = Significant at 99 % C.L.

The $\bar{d}$ values for mud and sand, and E.B.I. for mud were significantly different (95 % C.L.) between the No. 30 and No. 40 sieves. Otherwise no significant differences between indices were discernable for the Ohio River Basin substrates. The results of classification of the water based on the four indices; D, $\bar{d}$, T.C.I., and E.B.I., reveal that, except for $\bar{d}$ values from mud substrate, the means of the replicates using the Nos. 30 and 40 sieves fall within the same eutrophic category (Fig. 1).

Total taxa taken from Lewis and Clark Reservoir and retained by the No. 60 mesh sieve were nearly double those retained by the No. 30 sieve on each collection date (Tab. 4). Differences between the total individuals, total taxa, and between D, and $\bar{d}$ retained by the Nos. 30 and 60 sieves were highly significant (Tab. 3), indicating that perhaps erroneous conclusions might be drawn regarding eutrophic status of the water if data from the No. 30 sieve were used for interpretative purposes. However, the same eutrophic category was obtained from $\bar{d}$, T.C.I., and E.B.I. regardless of the sieve used (Fig. 2). In other words, the indices and the limits of the eutrophic categories are sufficiently broad to encompass the error resulting from the use of the No. 30 sieve.

Nutrient data collected at the Lewis and Clark station throughout 1969 showed the total phosphorus minimum and maximum values to be 0.017 and 0.059 mg/l, respectively, and the nitrate Nitrogen values between 0.106 and 0.262 mg/l (Martin 1970). These measurements would indicate mesotrophic water which is in agreement with the macroinvertebrate indices shown in Fig. 2.

Conclusions

Significant differences may occur between total number of individuals in bottom grab samples taken from silt and mud river substrates and washed in U. S. Standard Nos. 30 and 40 sieves. In reservoir silt substrate dominated by chironomids and oligochaetes, the differences between retention of both total individuals and total taxa in Nos. 30 and 60 sieves may be highly significant.

The use of either the No. 30 or No. 40 sieve for river substrates does not result in profound differences in the eutrophic classifications based on D, d, T.C.I., and E.B.I. values. In reservoir silt samples, highly significant differences between D and $\bar{d}$ indices

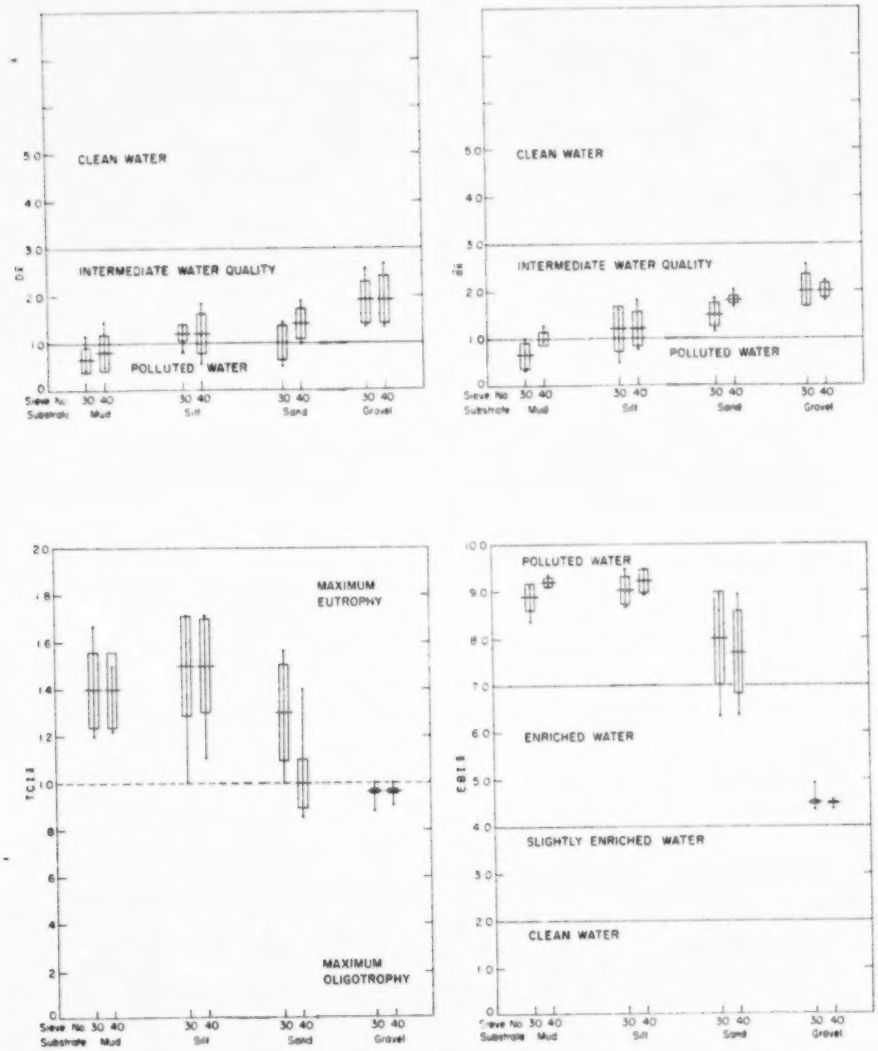

Fig. 1. Mean, ± 1 SD, and range for indices of eutrophication as calculated from Ohio River Basin benthic invertebrate samples taken in 1970 and retained by U. S. Standard No. 30 and No. 40 sieves, from four substrate types (6 replicates each).

may occur depending upon use of Nos. 30 or 60 sieves. However, sieve mesh size selectivity does not produce demonstrable differences in the general eutrophic category based on mean $\bar{d}$, T.C.I., and E.B.I. values.

Generally, as more organisms are retained during sieving, precision (lower CV) increases among samples.

Tab. 4. Benthic invertebrates collected from Lewis and Clark Reservoir.

Taxon	Date		Apr. 10				May 4				May 26				Aug. 27			
	Sieve mesh		30		60		30		60		30		60		30		60	
	Pollutional rank	(N_0, N_1, N_2)																
	(0—10)																	
Diptera																		
Chironomidae																		
Tanypodinae																		
Tanypus stellatus	6	1													1			
Psilotanypus bellus	9	2			19	18	2		19	10	3	5	13	10				
Procladius n. sp.	6	1	27	29	70	52	19	33	40	13	29	30	31	23		2	6	7
Coelotanypus sp.	7	1	18	7	95	93	1	2	48	26	17	21	87	77	19	30	62	62
Ablabesmyia annulata	5	1	10	17	11	13	10	4	15	11	6	6	10	8	2	12	28	37
A. mallochi	8	2			1				1				1			1	2	2
Orthocladiinae																		
Parakiefferiella	5	1							1				1	1			1	3
Epoicocladius sp.	3	0	1	1	2						2		1	2			6	2
Cricotopus n. sp.	5	1											2	1				
Chironominae																		
Chironomini																		
Chironomus sp.	9	2																
Cryptochironomus fulvus	7	1														1	2	
Harnischia curtilamellata	4	1							1									
H. incidata	4	1			16	12			15	9			2	3	1	1	17	18
Cryptotendipes pseudotener	4	1							1	1								
C. darbyi	4	1							1									
Leptochironomus sp.	5	1			16	2			13	11			12	15			6	6
Stenochironomus sp.	4	1							1	1								
Pseudochironomus sp.	3	0	1															
Paratendipes sp.	3	0	1		2	1	1	12	3	1								
Polypedilum digitifer	7	1	2	1	47	17		3	69	136			33	29	1	5	16	12
P. illionense	6	1											1					
Dicrotendipes neomodestus	4	1			1													
Paralauterborniella sp.	5	1			2				1									
Xenochironomus sp.	4	1						2	2									
Tanytarsini																		
Calopsectra sp.	4	1							4									
Paratanytarsus sp.	4	1			1										1			1
Cladotanytarsus sp.	5	1							1									
Stempellina sp.	2	0							1									
Ceratopogonidae	5	1		1		1		1	1	4			1					
Ephemeroptera																		
Hexagenia sp.	5	1	34	28	16	23	18	37	23	18	11	12	15	13	9	15	20	33
Caenis sp.	7	1						1					2					
Trichoptera																		
Oecetis sp.	5	1					1					2	4	1		2	5	
Zygoptera	5	1																1
Mollusca																		
Bivalvia	5	1			1	3	1	4	1		2	1		1			13	5
Musculium sp.	5	1													1			
Nematoda	5	1		3	10	2		2	1			1	1			3	2	1
Hydracarina	7	1								1								
Oligochaeta	8	2											1			1		
Hirudinea																		
Total Individuals			95	87	302	237	53	101	258	247	73	79	218	182	35	63	188	179
Total Taxa			9	7	17	12	8	11	19	17	7	8	18	14	8	11	14	14
Taxa in both reps			10		17		13		24		9		20		14		16	
Individuals x			91		270		77		253		78		200		49		184	
± 1 Standard Deviation (SD)			5.7		46.0		34.0		7.8		4.3		25.5		19.8		6.4	
D x			1.7		2.4		2.0		3.1		1.5		2.8		2.2		2.5	
± 1SD			0.13		0.60		0.30		0.20		0.14		0.50		0.40		0.02	
d x			2.3		2.6		2.0		2.6		2.3		2.8		2.0		2.7	
± 1SD			0.40		0.20		0.22		0.45		0.27		0.11		0.52		0.14	
TCI x			0.71		0.97		0.97		0.95		1.20		0.96		0.86		0.89	
± 1SD			0.06		0.04		0.22		0.07		0.08		0.05		0.32		0.05	
EBI x			5.3		6.2		5.3		4.7		6.5		5.6		4.7		5.0	
± 1SD			0.15		0.05		0.40		0.76		0.08		0.06		0.06		0.20	

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South Dakota, Ponar grab (2 reps.) for Nos. 30 and 60 mesh sieves — 1971.

Taxon	Date	Sept. 10		Sept. 20		Oct. 1		Oct. 12	
	Sieve mesh	30	60	30	60	30	60	30	60
	Pollutional rank (0—10)	(N_0, N_1, N_2)							
Diptera									
Chironomidae									
Tanypodinae									
Tanpus stellatus	6	1	1 2	2 2	1	1 1	1		
Psilotanypus bellus	9	2		3 1		2 7		5 3	7 7
Procladius n. sp.	6	1		10 4		10 8		27 34	2 3 43 38
Coelotanypus sp.	7	1	13 19	72 66	18 24	139 83	30 8	83 82	28 15 107 86
Ablabesmyia annulata	5	1	6 8	19 14	7 10	9 22	12 13	13 15	11 11 11 20
A. mallochi	8	2			1	1	1		1
Orthocladiinae									
Parakiefferiella	5	1		1					
Epoicocladius sp.	3	0	1 1	1		3 1		3	1 2
Cricotopus n. sp.	5	1							
Chironominae									
Chironomini									
Chironomus sp.	9	2		1					
Cryptochironomus fulvus	7	1				1			
Harnischia curtilamellata	4	1							
H. incidata	4	1	2 1	4 3		4 1	1	2	3 5
Cryptotendipes pseudotener	4	1		1					
C. darbyi	4	1							
Leptochironomus sp.	5	1	1	2 2		1 1	1	6 1	12 6
Stenochironomus sp.	4	1				1 1	1		
Pseudochironomus sp.	3	0						1	
Paratendipes sp.	3	0							
Polypedilum digitifer	7	1	2	6 2		6 14	1	28 18	2 13 61
P. illinoense	6	1							
Dicrotendipes neomodestus	4	1							
Paralauterborniella sp.	5	1							
Xenochironomus sp.	4	1							
Tanytarsini									
Calopsectra sp.	4	1							
Paratanytarsus sp.	4	1							
Cladotanytarsus sp.	5	1							
Stempellina sp.	2	0							
Ceratopogonidae	5	1							
Ephemeroptera									
Hexagenia sp.	5	1	10 13	9 15	8 8	6 16	14 33	12 17	18 27 16 25
Caenis sp.	7	1							
Trichoptera	5	1							
Oecetis sp.	5	1				2 6		3 1	1 2
Zygoptera									
Mollusca									
Bivalvia									
Musculium sp.	5	1	2	5 3		5 4		2 12	1
Nematoda	5	1						1	
Hydracarina	5	1		2				3	1 2 5
Oligochaeta	7	1							
Hirudinea	8	2		1				1	
Total Individuals			36 46	135 118	35 42	189 165	58 57	186 187	63 56 218 257
Total Taxa			8 7	13 13	5 3	13 13	5 6	13 11	7 4 13 11
Taxa in both reps			9	16	5	15	9	14	7 13
Individuals x			41	127	39	177	58	187	60 238
± 1 Standard Deviation (SD)			7.1	12.0	5.0	17.0	0.7	0.7	5.0 27.6
D x			1.8	2.5	0.8	2.3	1.1	2 1	1.1 2.0
± ISD			0.27	0.03	0.42	0.04	0.18	0.27	0.50 0.30
$\bar{d}$ x			1.9	2.1	1.4	1.9	1.5	2.4	1.7 2.4
± ISD			0.11	0.12	0.16	0.52	0.03	0.06	0.15 0.20
TCI x			1.10	0.74	0.83	1.00	0.80	1.10	0.90 1.00
± ISD			0.11	0.16	0.23	0.06	0.02	0.11	0.10 0.12
EBI x			4.4	5.6	4.9	5.7	4.0	5.8	4.3 5.6
± ISD			0.25	0.23	0.08	0.30	0.96	0.21	0.43 0.60

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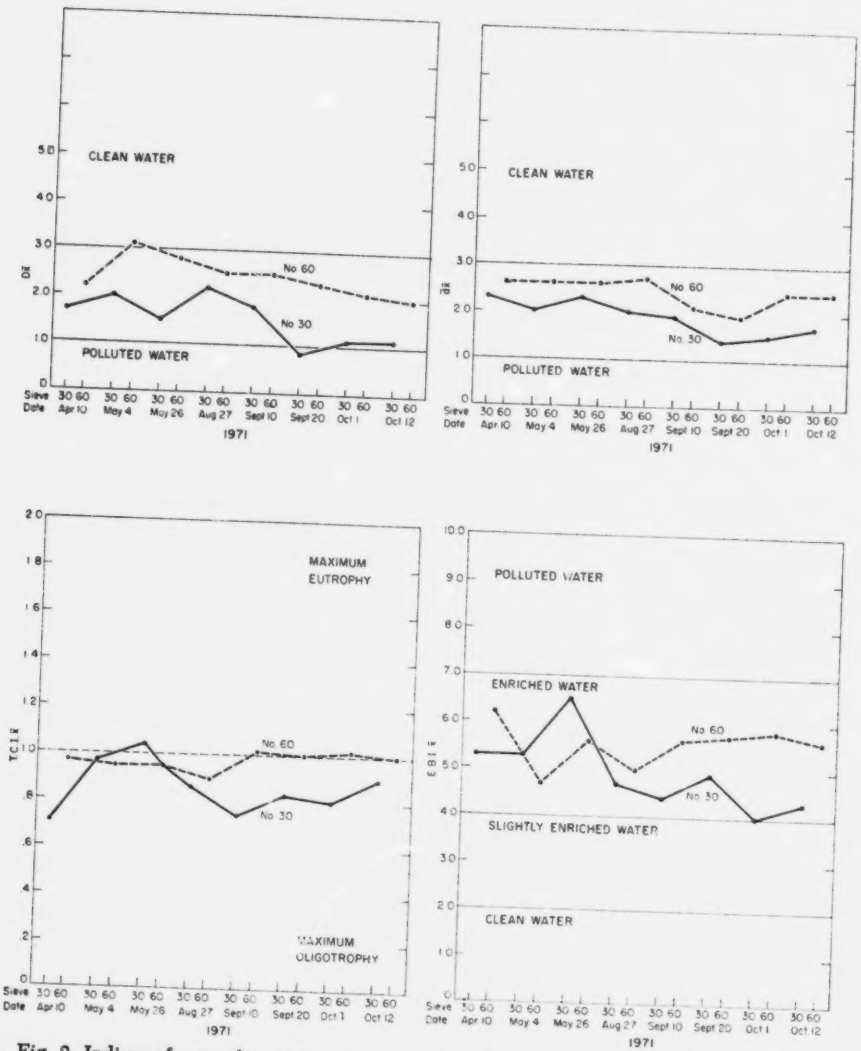

Fig. 2. Indices of eutrophication as calculated from benthic invertebrate samples taken in 1971 from Lewis and Clark Reservoir and retained by U. S. Standard No. 30 and No. 60 sieves.

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Discussion

JÓNASSON: A mesh size of 234 microns is far to coarse to catch chironomid or tubificid populations quantitatively. A mesh size of less than 100 microns is more appropriate.

HUDSON: This paper was not specifically addressed to the quantitative retention of invertebrates by the various sieves. Our work indicated substantial losses with a No. 60 sieve. In Lewis and Clark Reservoir only 5—9 % of the No. 60 sieve catch is made up of first and second instar chironomids. However, a No. 60 screen will retain quantitatively around 80 % of the North American chironomid species in the fourth instar. This efficiency should produce reliable data on distribution and abundance and some life history information. If production estimates are to be made then the sample should be kept intact without sieving or sieved with a mesh size of 50 microns.

DAVIES: I would like to suggest that the lack of differences between the 2 values of the eutrophication indices reflects the insensitivity of the indices rather than the lack of difference between meshes.

HUDSON: The purpose of this study was to determine whether mesh size would substantially alter the results obtained using four popular indices, not to develop new indices or evaluate the adequacy of existing indices.

SAETHER: The T.C.I. and E.B.I. attach high numbers to eurytopic and tolerant species. Will not this give completely wrong results when all species present are eurytopic and given very high numbers? Your figure from Lewis and Clarke Reservoir seems to indicate this. Would it not be better only to rely on the number of oligotrophic intolerant species as related to the total number of species?

HUDSON: Because of the lack of environmental requirement information of many species, the "eurytopic" assemblage is admittedly large compared to the total number of species. It follows that E.B.I. and T.C.I. will yield more precise definition of water quality as requirements become known. Fig. 2 shows that T.C.I. and E.B.I. give essentially the same results as D and $\bar{d}$, i.e., mesotrophic water quality.

*U.S.Government Printing Office: 1976 — 657-691/1306 Region 5-11